Salt of the Earth: Salt-Water and the Limits of Growth

(The text of a talk given to the 2001 Adelaide Festival of Ideas by John E Leake)

This talk although delivered some 10 years ago remains relevant; the current "issue" is human induced climate change rather than salinity. In the case of climate change the issue is caused by the additional energy forced into the weather system due to the 'greenhouse' effect and increased emissions of green house gases provided by our industrial growth, mostly since about 1870. We don't know precisely how this will play out but it is IID's view that humans have the capacity to react the damage they have caused and that it is in through *Rural Development* and education that this can be achieved, as discussed below for salt and water.

Ladies and gentlemen, the title given to me for this talk takes growth as a given, implied I suppose is that growth is a "good" to be always pursued - or a necessary condition of life. Perhaps it has been - but can it always be? And how would we change this if we wanted to? Is growth limited to the economic kind? These questions, raised by the assumptions in the title, are outside of my brief but warrant attention.

I want to be optimistic about the subject as defined, to create for you a silver cloud and to return only briefly to this black lining at the end.

Why do I want to be optimistic?

Firstly, because I can see that the pessimistic landscape is well and truly occupied, vast entrenchments can be seen from the high ground to the low ground - there seems little room for some thing new.

Secondly because while I believe pessimism is good for sounding the alarms it is of little use to those who might be motivated to act, to do something about a problematic situation.

But the third and most important reason is that I think there are reasons for optimism - at least for a few generations or so.

First the general

Why is everybody so pessimistic? - Apart from the fact that pessimism sells more copy than optimism so that bad news drives out the good.

When the Malthus to Paul Ehrlich tradition told us population growth would outstrip food production soon they were projecting then present events into the future without taking sufficient account of people's reactions to resource shortages. But reaction is common; otherwise there would be no tulip manias, no stock exchange booms. Entropy would be increasing in our neighbourhood but it seems not to be - at least not yet you might say.

But many systems, as von Bertalaffy[i] and Boulding[ii] told us in the 1950s' and 60's, are not like this, they self organise, they inherently react to events to preserve themselves - the medicos call this homeostasis, the engineers call it cybernetics and it works while ever the system is open and has a through put of energy and material. It is a mechanism possessed by all living things and many machines. It is not inherently an externally controlled process; it is internal and automatically reactive.

Increasingly, many people see our biosphere as a self-organising system of sub systems that acts collectively - as if a single living thing, exhibiting homeostasis, or cybernetics -. This idea was popularised,

amid much scientific controversy in the 1970s', by James Lovelock[iii] as the 'Gaia' Principle, named for the Greek goddess of the earth.

We as humans and as Australians are part of this system, we cannot hide and we are not outside it. To keep this perspective I am going give international as well as national examples of what we have done and can do with salt and water.

Lovelock's ideas arose from the observation that many of the governing conditions of life on earth, such as atmosphere, seem to change little, a least not enough to wipe out life in spite of the many assaults the earth has been the target of that would seem to be necessarily fatal by themselves, such as extreme ultra violet light and asteroid collisions.

To give one example, although the energy output of the sun has increased by some 30% in the last 3.5 billion years since life began here, the average surface temperature on earth has remained in the range favourable to life, between 10º and 20º C. We have neither frozen nor boiled as we would on the surface of Mars. Lovelock used a metaphor of a world of black and white daisies to explain this. In this imaginary world when the temperature increases, life forms like white daisies prosper, reflecting more light and driving the temperature down to the point where black daisies that absorb light and heat the earth are favoured and so on. Water liquid and vapour balances are a key 'Daisy' in this mechanism.

Salt, the ions of which are essential for all cellular life are another example. Geological evidence indicates that the salinity of the sea has not changed much since life began and certainly not enough to threaten life. Lovelock points out that if we try to calculate the age of the sea from known salt inputs from rivers and tectonic processes we come to only 60 million years, not the more than 3.5 billion years it has been in existence. If salt had accumulated from the mantle at these suggested rates over that time the concentration, now averaging about 3.4%, would after 3.5 billion + years, far exceed the 6% at which most living cells would fly to pieces.

So where is all this salt going? The short answer seems to be that the jury is still out, it is clearly cycling but what are the sinks and where is it hiding? Lovelock suggests that purely physical processes based on evaporation in shallow seas, undoubtedly accounts for a lot and it hides there in clay covered salt deposits that sink under the weight of the clay (Halo-decking this is called, Halo from the Greek for salt). But Lovelock says if these processes operated purely inorganically they would have been random in space and time and would have produced variations impossible for life, as we know it. Instead he speculates about homeostatic biological processes such as our Great Barrier Reef and ancient stromatolites forming additional evaporation basins when conditions encourage this. These he postulates as the daisies in the salinity system.

There is another cycling process he did not refer to; our very own Teakle pointed out in 1937 that much more salt circulates via tiny crystals of ocean salt in the atmosphere (we have a halo of salt!) than is produced by weathering, to be washed in (halo-precipitation Yensen[iv] has called this), laid down and covered (more halo-decking) or added to river flows. Teakle said 80 % of our soil salt (and soil salt world wide) comes from this source (estimated at 12.9 kg/ha/yr compared to 2.6 kg from other sources, eg weathering, volcanos, etc.). This seems the link with homeostasis; the daisies in the system being salt/rainfall and soil/ plant processes and the scale may be sufficient to influence ocean salinity. We humans have now influenced this recently at least on land - perhaps we can react to what we have done.

Of course, I suppose you are thinking, even though these homeostatic reactions can be rapid, they surly can't keep up with *Homo sapiens*. Well, although we have clearly sped things up quite a lot, so have our reactions. We have turned in to quite an animal - we seem to be both manipulating our genetic makeup and increasingly escaping from its limitations through technology and social processes. I was raised on the nature nurture debate and thought it timeless. Cramer suggests otherwise and summarises this idea with

a calculation that we now generate almost twice the intellectual information, (10^{18}) bits annually, as genetic information exists in the cell nucleus (Cramer[v]). By contrast as little ago as the invention of moveable type a couple of hundred years ago, the annual information flow was in the neighbourhood of 10^{10} and for most of our short span it has been less - and thus equipped, we can operate as powerful homeostatic agents, a kind of post Darwinian world!. The question I can almost hear you asking is 'perhaps instead we have just become some vicious feedback process - is there any evidence that we do react at the necessary speed for homeostasis to occur?

The answer seems to be yes - at least so far - there are many examples where we have speedily got our selves into trouble and just as speedily got our selves out of it. This is unlike the world between the agricultural and industrial revolutions - when fluctuations in the death rate moderated the natural increase made possible with increased food[vi].

One very good example of this was CFCs, discovered about 70 odd years ago, detected in the atmosphere about 30 years ago, perceived as a global threat about 20 years ago. The reaction was a treaty to eliminate its use about 10 years ago; with the apparent result that loss of Ozone reached only 4% in 2000 instead of 10% and seems likely to drop now[vii] even *Laisse Faire* capitalist China has reacted to this positively.

Another recent example was the banning of atmospheric bomb testing and there are many examples of reactions to the excesses of industrialisation that began in the 1890's, such as the reappearance of salmon in the Thames, smog reductions in Britain and Mercury pollution reductions in Japanese seas. There are more trees in the Eastern United States than there were a hundred years ago[viii]. There are more trees in Australia now than in 1788, but we call them woody weeds in the semi-arid areas where this has occurred - for some reason that escapes me.

Now the Particular

In Australia salt and water ratios are limits to growth and are inextricably linked although we give less attention to salt for reasons I will go into a bit later. I would like to start with water since it is intuitively the most direct limiting factor on food production and so growth.

History shows we were already reacting to the fears of famine when the Club of Rome articulated these in the 1970's. And what a reaction! Not only was famine abated in an aggregate sense but the productivity of irrigation water increased by 3.3 times[ix] and the real cost of grain based foods dropped by 50% between the 1960's and the 1990's. Multiplier effects accompanied this; improved productivity increased employment, particularly of landless labourers so that in India, for example, the percentage of people below the absolute poverty line decreased from 50% to about 35% according to Datt[x] (this still represents a rise in actual numbers). This was due to both public investments in dams and irrigation canals and to private investment in tube wells (which now account for some 50% of India's food production).

It is commonly believed that plant breeding with improved input supply resulted in the more and cheaper food. However, the improvement in productivity of water has been largely unappreciated; some say we should have called it a blue revolution. The International Water Management Institute points out that this was a greater achievement than any previous improvements in irrigation technology. There were two main reasons for this. Firstly, because once the crop canopy is closed water use no longer rises proportionally with yield so that irrigated field layout contributes to Water Use Efficiency (WUE) and secondly because water storage and canals multiply the number of times water can be used in irrigation. An unintended consequence of this in Australia is that water return to the river has declined exacerbating problems due to over allocation of available water from the Murray Darling system.

And what of Salt?

Salt of the earth! In some places and times its scarcity makes it a traded good, salary for Roman soldiers - hence 'not worth his salt'. In other times and concentrations deadly to life - hence the fabled ploughing of salt into the Carthaginian farm lands by the same Romans. The Romans knew a lot about salt, the technology of our own world-class salt industry is not different than theirs in principle. As with water, salt is not a limit to growth per say, rather it is the fluctuating ratios between the two that creates limits, particularly in dry continents like ours.

Salt has been a more intractable problem than food production and water use. It is insidious, its causes and impacts don't often coincide in time or space and not knowing who or what is to blame we have usually moved on when the problem gets bad enough, the empires of fertile crescent, the Indus, Inca - all have moved on due to salt - as will many farmers in Western Australia the way things are going. Most mechanical solutions are energy intensive and we have only limited successes. For instance there is apparently a success on the Murray through salt interception schemes that have already reduced salinity at Morgan ahead of targets. Unfortunately this seems not sustainable since the salt will return to the Murray in about 150 years through similar aquifers from where it has been intercepted.

What of the future?

While population growth rates are slowing, food demand is rising and we will need more food in the next 50 years than was consumed in the last 10,000[xi] a frightening thought. According to Jim Peacock, head of the CSIRO division of plant research[xii], we can expect "quantum leaps" (his words) in productivity, nutritional quality and environmental benefits from genetic engineering although he says public acceptance of GMO's may delay this. As noted above, such improvements do not necessarily require so much more water for irrigation. Peacock refers mostly to classic fresh water agriculture but he notes that a combination of classical plant breeding and genetic engineering can also be applied to adapting plants to water logging and salinity.

We should watch this space since we have far more salty water in our landscapes than fresh. Such plant-based solutions are not energy intensive and are the classic homeostatic process. Plant can either keep the salt down in its beds (preferable) or help us live with it where we can't keep it down or drain it. But there is a way to go since, as Yensen has said, plant research has been based on Glycophytes (fresh water plants) rather than Halophytes[xiii] (plants adapted to salt), such as Mangroves. Mangroves ecosystems are among the most productive on earth; we just haven't domesticated them yet, except in shrimp production in Asia.

And what of the sea? We have hardly progressed beyond hunting in sea-based food systems - about half the living biomass in the world is to be found in 2% of the sea and we know 'reefs' even old oil rigs increase the habitats suitable for biomass. South Australia may have a success story here to rival wine as we learn more about this by doing it.

Since we have money, a fine plant based research capability, a salt problem and no sustainable agricultural systems at present, Australia may be the right place to make breakthroughs in the area of plant based adaptations to salt balance changes. There are sustainable agricultural systems in the world but they are social systems as much as agronomic ones and many have declined or disappeared as we have pushed for greater output. Wet rice in south east Asia is one; the Mongolians exploited a grass based system perhaps more 'fragile' than ours for perhaps 4,000 years by managing a mixture of domesticated and wild animals. The Chinese have supported almost 25% of the world's population for millennia on much less of its arable land but the have around 50% of the worlds pigs (53% at the last count). The key has been the evolution of social systems that supported a sustainable cycling of resources over generations - and leaching salt.

Please note the enabling social and belief systems.

Money for this purpose pleases politicians.

Water supply and demand

Let me be clear from the outset: we have plenty of water the problems are distribution water quality and water use efficiency.

To take supply and demand, it has been estimated that a quarter of the world's population, or a third in developing countries, 1.4 billion people, will experience severe periodic water shortages in the next quarter century. Slightly more than one billion live in arid areas where they will experience absolute water scarcity by 2050[xiv]. The great problem areas are the North China Plain and the Punjab in India and Pakistan and of particular concern is depleting water tables in both places that will not be cheap or easy to solve. But China, India, Africa (and Australia) all have water surplus areas from where water might be diverted into existing systems and perhaps even re-injected into some aquifers. However these are high-energy infrastructure solutions that require a shift in Western thinking if they are to be funded (except in China).

Water supply can be a deceptive matter. Water from precipitation is a renewable, non-depletable resource (one of the few) in that you start each year with much the same potential average amount (climate change permitting!). Secondary water supplies, such as dams and hydro-schemes and canals constitute multipliers of the primary supply, and these can mean that the sum of all the deliverables can be much more than the primary supply. Of course this is not without its costs. I remember thinking when I was at school that it must be much cheaper for a boarding school at the bottom end of the Murray to make the soup I was drinking with all the salt and crud in it than a soup made at say Albury. I will return to Albury as it has a possible place in our future.

Another secondary source is ground water, most of this is considered to be stored precipitation but much of it may have separated from the original rocks (along with natural gas), such as our Great Artesian basin[xv] there are chemical complications in using this in Australia and the production of gas would likely be impacted by over use of water. However there are other huge underground aquifers such as in the sand country south of the Kimberley ranges' in WA that might be used safely and certainly plenty of land.

In dry farming and grazing areas such as much of Australia, the Middle East, Central Asia and sub-Saharan Africa, water harvesting an ancient, almost lost art. Climate is a kind of accident in arid areas but still produces huge fluctuating resources in the form of grass and shrub lands. It has always amazed me that we have done so little to capitalise on the capacity of our kangaroos and emus to chase storms to produce usable protein instead of trying to push the boundaries of our imported animals and sedentary land title systems developed for different systems. I hope addressing our reconciliation needs involve utilising indigenous knowledge in this area. The Mongolians lived on a sustainable mixture of wild and domestic herbivores for perhaps 4,000 years until the advent of the machine gun and railways.

Water Use Efficiency

We have to think of system efficiency with water use, and this will produce dramatically different reactions in different situations. Simple recipes like ‘getting prices right' high efficiencies technologies' or ‘water users associations‘ are not enough. For example allocative efficiency can be achieved through water pricing in a country like Australia where the regulatory controls can work, and cost less than the benefits. This is not possible in many countries - such as India - where as much as 50 % of the nation’s food is produced from millions of tube wells.

We have to understand what we want as products from water and what we mean by efficiency. Water management to enable it to be used in agriculture once before evaporation may be considered efficient by the farmer but considered very inefficient where water previously leaked from crops has been needed to recharge an aquifer also used in agriculture or where it is used again downstream, needed as an amenity or to produce an environmental service. In another situation water managed this way may be considered very efficient such as where leaked water causes water mounding and dry land salinity. The situation varies, even within Australia but is unfortunately often seen in single disciplinary terms, such as hydro-geological, social, political, environmental or agronomic.

Australia's carrying capacity

The Australian Academy of Technology Science and Engineering recently sponsored a conference called Sustainable Australia. At that conference Fitzpatrick[xvi] concluded that there were no immediate limits to growth up to a population of about 35 million by 2050 based only on optimising existing resources such as the MDB (and others totalling 30% of precipitation) by diverting irrigation water to more productive agricultural and other uses.

Let me repeat Australia is not short of water. 70% of our irrigation is produced in the MDB from only 4% of our primary precipitation. 64.8% of Australia's water resources lie in the North and North East down to Brisbane. To date only a small proportion of this water has been diverted for human use.

To make a simple calculation, if the 30 odd % of our water supplies in the South Eastern Australia can be optimised to support 35 million by 2050, then another 60% might support another 70 million or over 100 million in total. The figures jump even further if we assume a standard of living of our near neighbours. A Chinese water engineer once told me he thought Australia could support 350 million people based on such calculations and that we are already significant food and energy exporters. He then asked quite pointedly what I thought we had done to deserve such riches. We are not alone on this earth and, seen in this light, I think Tim Flannery's estimate of our human carrying capacity may be simply impractical.

I know there are serious soil and water quality issues at stake here but an overall national policy is needed to consider water in its totality including groundwater, unregulated rivers and water quality in the context of our strategic, social and ecological interests.

At the present time we seem to be responding to a rather narrow interpretation of these interests. Albrecht[xvii], at the conference already referred to, discussed a great many potential water developments including dams, massive pipelines that would enable the use of more water. To discuss pipelines, at today's rates, a 2m-diameter pipeline could cost around $1.2 billion for a distance of 1,000km to link up a water rich region to the north with an overloaded system in the south. Compare this with what our State Bank of South Australia spent underwriting Victorian real estate not long ago and have nothing to show for. This potential has international an echo in China, India and Africa as I mentioned earlier.

Albrecht points out Australia's commitments to reducing Greenhouse Gas and the role of hydro-electricity in this endeavour need also be considered in the water debate. In order to meet Australia's implied commitments to the Kyoto protocol, he suggests we would need another two Snowy schemes.

He goes on to discuss the financing of necessary water and salinity works and makes an interesting analogy between petrol and water in proposing a consumption levy on water.

He points out that we now collect about $10 billion in petrol taxes and suggests a comparatively miniscule tax on water would go a long way to raising the $3.7 billion per year which environmentalists suggest is needed to redress current problems.

We can do a lot if we have the will. I understand that had South Australia spent less than that spent on the Myer REM centre, on purchasing and moving a suburb of Albury to enable sufficient environmental flows to be released from dams, we could by now have to salt our soup on purpose[xviii]. Bashing the Victorians is popular in South Australia and they have a bit to answer for they have about 3% of Australia's agricultural land but produce higher gross agricultural production because they receive almost free water for irrigation and have the power to prevent its reallocation. These are social not engineering issues.

I would now like to draw some of these themes together

In Australia, as in other areas of the world we have enough water; we can relocate it and adjust to its quality - if we want to.

More vision is needed to address salt than water since the causes and impacts are often separated in time and space but Australia has a rather unique combination of resources, a salinity difficulty and the research capacity to hope we can do some thing world class in this area - if we want to.

The social information flows are there; the mighty market delivers them in all sorts of areas but we need to pressure our governments for more far sighted consideration of the strategic options facing us than the 'brawlers of the auction mart', might otherwise deliver us, to co-opt Oscar Wilde. This is not easy in a political system that tends towards minor adjustments to the status quo as this does not lend itself to looking at things in an integrated way. We seem about to spend more money on salt. Falvey has said that a great salt gravy train seems to be pulling out of the station but it is losing carriages all over the landscape in local one-dimensional issues for want of communication between the chef and the engine driver.

I would like to put in my plea that we see our selves as part of our biosphere or 'Gaia' and not somehow outside of it - either thinking it should be subservient to our requirements - or thinking of ourselves as some dark force upsetting 'mother nature'.

We seem often to divide our attention, in some instances to focus on environmental issues and then in other circumstances on production. This is a false and ultimately destructive dichotomy. Our Institute has sponsored a book on this subject jointly with the Crawford fund (Falvey 1996.[xix]

So we can be optimistic, there are directions to work in and the limits to growth may be further off than we imagine.

Now to the black lining I referred to at the beginning, some chap called Sir William Osler once said 'natural man has only two primal passions, to get and beget'. Both of these produce economic growth. Our beloved market system, which responds well to primal passions, has certainly produced growth in abundance. According to the UNDP world development report of 1998 productivity has grown 20 times over the 150 years in which the world's human population has only trebled. They say the trend looks to be continuing, although a lot of attention is needed to the distribution.

The population only trebled in 150 years I hear you say!! A growth rate of 2%!

There will be limits to growth. In the 1940s, a supporter asked India's Mahatma Gandhi, "How long it will it be before India is as rich as England. Gandhi's response was: if it took half of the world to make England as rich as it is, how many worlds it will take to make India that rich?"

Present population estimates have something like a steady state occurring fairly soon. Well maybe, but only if the target stays still long enough for us to get a good look at it.

I think, if we are not able to get this ‘getting and begetting' that Sir William Osler spoke of under control soon our decedents are likely to see much more about fluctuating death rates.

The black lining in our silver cloud is our impulse to growth. We need a different type of growth, a social or spiritual growth, if we are to survive as an important homeostatic part of the biosphere. We can do this, Richard Dawkins coined a word Memes to denote ideas or concepts that evolve and grow and spread rapidly. William Burroughs called these "viruses of the mind" and we now co evolve with these. We to discover new viruses or rediscover and preserve old virus such as those painfully discovered by indigenous Australians following a previous episode of ‘getting and begetting' as Tim Flannery has described.

I would like to finish with a so-called ‘Grock’ a humorous kind of poem by Piet Hein, a Danish polymath of some fame.

WE DO OUR BEST

Or do we?

Modern man has the skill;

he can do what he will.

But alas -being man

he will do what he can.

Piet Hein (1905-1996)

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[i] Von Bertalaffy, L, An Outline of General Systems Theory, Penguin1950.
[ii] Boulding, K E, The Economics of the Coming Spaceship Earth. In *Environmental Quality in a Growing Economy*, John Hopkins University Press Baltimore, 1968,
[iii] Lovelock James, Gaia a New Look at Life on Earth, Oxford 1979, 1987, 1995 & 2000.
[iv] Yensen, N P, Pers. Comm., 2001.
[v] Cramer Chaos and Order, The Complex Order of Living Things, Wiley-VCH, October 1993.
[vi] Cipolla C, The Economic History of World Population, Penguin, 1962.
[vii] Beyond Discovery. Ozone Loss, the Chemical Culprits, www4.nas.edu/beyonddiscovery.nsf/web/ozone6 11-06-01
[viii] Easterbrook, G, A Moment on Earth; The Coming Age of Environmental Optimism Penguin, 1995.
[ix] Seckler D, Revisiting the IWMI Paradigm; Increasing he efficiency and productivity of water use. International Water Management Institute Sri Lanka (IWMI), 1999.
[x] Datt, G, Poverty in India and Indian States: An Update. FNCD Occasional Paper No 47. The Food Policy Institute USA, 1988.
[xi] Dupont A, Food, Water and Security: What are the Connections? Proceedings of "Food, Water and War Security in a World of Conflict. Crawford Fund/ACIAR Parliament House Canberra, 2000.
[xii] Peacock Jim, Sustainable Australia? Australian Academy of Science Technology and Engineering (ATSE) Symposium, November 2000.
[xiii] Yensen N P, Saline Agriculture and New Halophyte Crops American Assn for the Advancement of Science March 19-23 (1985):27
[xiv] Seckler D, Molden D & Barker R., Water Scarcity in the 21st Century (IWMI), 1999.
[xv] Endersbee L A, A New Understanding of the Groundwater Resources of the Great Artesian Basin ATSE Occasional Paper no 2, 2001.
[xvi] Fitzpatrick E N, Water and the Australian Economy ATSE Symposium, November 2000
[xvii] Albrecht M C Stewardship of our Water for Responsible Growth, ATSE Symposium, November 2000
[xviii] Cole P. Pers. Comm. 2000.
[xix] Falvey J L, Food Environment and Education: Agricultural Education in Natural Resource Management. The Crawford Fund for International Agricultural Research and the Institute for International Development Limited Adelaide, 1996.